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THE FRIENDS FACTOR:  
HOW STUDENTS' SOCIAL NETWORKS AFFECT THEIR ACADEMIC ACHIEVEMENT AND WELL-BEING?

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The Friends Factor: How Students' Social Networks Affect Their Academic Achievement and Well-Being?

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**ABSTRACT**

In this paper, we estimate the influence of social relationships on educational attainment and social outcomes of students in school. More specifically, we investigate how losing different types of social relationships during the transition from elementary to middle school affect students' academic progress and general well-being. We use social relationships identified by the students themselves in elementary school, as part of a unique aspect of the Tel Aviv school application process which allows sixth-grade students to designate their middle schools of choice and to list up to eight friends with whom they wish to attend that school. The lists create natural "friendship hierarchies" that we exploit in our analysis. We designate the three categories of requited and unrequited friendships that stem from these lists as follows: (1) reciprocal friends (students who list one another); and for those whose friendship requests did not match: (2) followers (those who listed fellow students as friends but were not listed as friends by these same fellow students) and (3) non-reciprocal friends (parallel to followers). Following students from elementary to middle school enables us to overcome potential selection bias by using pupil fixed-effect methodology. Our results suggest that the presence of reciprocal friends and followers in class has a positive and significant effect on test scores in English, math, and Hebrew. However, the number of friends in the social network beyond the first circle of reciprocal friends has no effect at all on students. In addition, the presence of non-reciprocal friends in class has a negative effect on a student's learning outcomes. We find that these effects have interesting patterns of heterogeneity by gender, ability, and age of students. In addition, we find that these various types of friendships have positive effects on other measures of well-being, including social and overall happiness in school, time allocated for homework, and whether one exhibits violent behavior.

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## I. Introduction

There are many educational programs or practices that separate students from their social network in school or class. For example, policies that enhance school choice in order to increase school productivity (by introducing competition among schools) often detach students from their childhood social network.<sup>1</sup> Other policies that often lead to students being separated from their friends include educational reforms that redesign school zones or catchment areas, programs which expand student access to high-performing schools,<sup>2</sup> or reassigning students when they advance to a higher grade in primary school.<sup>3</sup> Social and welfare programs, such as the US Moving to Opportunity, also detach children from their childhood social environment.<sup>4</sup> The consequences of such social detachment are usually not taken into account in policy making circles, even though it is well documented in the sociology and psychology literature that students' social circles are important for their academic performances and overall development (Wentzel 1993, Roseth et al. 2008).<sup>5</sup>

In this paper we investigate the influence of social relationships on educational attainment and social outcomes of children in school while carefully addressing the identification and the causal nature of the relationship. We base our analysis on a school choice program that started in Tel- Aviv in 1994 which allowed students who completed primary school to choose their middle school.<sup>6</sup> While much of the literature on school choice compares the benefits that accrue to students who receive their first school choice relative to students who did not, this paper highlights another important and generally overlooked angle

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<sup>1</sup> Many countries have pursued this type of policy. See for example papers on the U.S. (Cullen et al. 2005), (Angrist et al. 2011); U.K (Gorad 2001); New Zealand (Fiske and Ladd 2000); and Colombia (Angrist et al. 2002).

<sup>2</sup> For example, the recently approved Boston Public School's proposal to reallocate facilities in an effort to expand access to high performing schools has faced strong opposition from parents of children who under the new plan will be detached from their childhood environment [<http://www.change.org/petitions/mayor-thomas-menino-stop-bps-superintendent-johnson-s-plan-to-uproot-mission-hill-school-k-8-2>].

<sup>3</sup> For example, the Wake County school district has moved up to five percent of the school population in any given year during the 1990s in order to balance schools' racial and income composition (Hoxby and Weingarth 2005).

<sup>4</sup> For an analysis of the Moving to Opportunity Experiment, see Katz et al. 2001, Katz et al, 2007, and Kling et al. 2005.

<sup>5</sup> Many papers emphasize the social difficulties that students face during the transition from elementary school to middle school due to puberty (Wigfield et al. 1991), and changes in social relationships with peers, family, and authority figures (Elias et al. 1985, Eccles et al. 1993, Rudolph et al. 2001). This literature stresses the important role of friendships in the adjustment process of students to the new school environment and even suggests that there are long run implications of adjustment difficulties in middle school to latter educational attainments (Wentzel 1998, Wentzel et al. 2004, Nelson and Debacker 2008, Veronneau et al. 2008). Furthermore, friendships ties among children (especially of reciprocal nature) and the related parental networks are also both central dimensions of social capital and its effect on human capital underscoring the importance of the potential negative effect of breaking down social networks of adolescents (Coleman 1988).

<sup>6</sup> See Lavy (2010) for a further analysis of the effect of the Tel Aviv choice program on student achievements and behavioral outcomes.

of this process: the importance of maintaining one's social circle throughout middle school.<sup>7</sup> Our evidence suggests that taking into account the students' social circle can create a better assignment of students among and within schools in general and improve the design of school choice programs in particular.

For our research, we take advantage of a unique dataset from a Tel Aviv school choice program that allows us to analyze the students' social relationships as they are undergoing a major transition, from elementary to middle schools. These social relationships are identified by the students themselves as the result of an unusual aspect of the Tel Aviv school application process, which allows sixth-grade students to designate their middle schools of choice and to list up to eight friends with whom they wish to attend that school. The lists create natural "friendship hierarchies" that we exploit in our analysis. We designate the three categories of requited and unrequited friendships that stem from these lists as follows: reciprocal friends (students who list one another), and for those whose friendship requests did not match: followers (those who listed fellow students as friends but were not listed as friends by these same fellow students) and non-reciprocal friends (those who were listed by fellow students but did not reciprocate by putting the same students on their own lists).

Using these data, we examine the consequences of the school transition on the number of a student's friends and the types of friendships. Then, we estimate the effect of these relationships on their educational attainment and social well-being. Since the assignment of students in school is not random, the number and types of students' social relations can be correlated with the schools and the students' characteristics. Following students from elementary (sixth grade) to middle school (eighth grade) enables us to overcome potential selection bias by using the fixed-effect methodology. This methodology eliminates student and school or class unobservables that could be correlated with the error term and solves the correlated effect problem. We further demonstrate that the changes between sixth and eighth grade in the number of the various types of friendship are not correlated with observable background characteristics, evidence that reduces further the likelihood that our results are derived by selection bias.

Our results suggest that the presence of reciprocal friends in class has a positive and significant effect on test scores in English, math, and Hebrew. This effect is limited to the first circle of such friends, while any extensions of the social network have no effect on the

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<sup>7</sup> The optimal design of school choice programs is the focus of much recent research. For example, in a recent series of studies, Abdulkadiro et al. 2003, 2005, 2011 and Pathak and Sönmez (forthcoming), analyze the optimal design of admission rules in school choice programs where students take into account strategic considerations when submitting their preferences for schools.

academic performance of students.<sup>8</sup> The presence of followers also has significant positive effects on student outcomes and this effect also carries to outside of the classroom. Non-reciprocal friends in class and in school have the opposite (negative) effect on a student's learning outcomes. We also examine the effect of the "quality" of reciprocal friends, which we measure by their parental schooling, and find that it has a positive effect on cognitive outcomes. We also find that these effects have interesting patterns of heterogeneity by gender, ability, and student age. In addition, we present in the paper other effects of these various types of friendships on other measures of well-being, including social and overall happiness in school, time allocated for studying at home, and whether one exhibits violent behavior.

The rest of the paper is organized as follows. In section II, we present a review of the literature. In section III, we present our data. Section IV explains the identification and estimation methodologies. We detail our results in section V and offer conclusions and policy implications in section VI.

## **II. Literature Review**

From childhood to adolescence, social relationships play a central role in shaping individuals' attitude toward education (Coleman 1961). The psychology and sociology literature suggests that various kinds of relationships have different impacts on individual behavior<sup>9</sup>. This literature has examined the relationship between friendship networks and children's educational outcomes and social well being, but it presents evidence that is generally cross-sectional in nature, with little attention paid to a potential correlation between omitted variables friendship.

Many papers have studied extensively the role of social interactions in shaping individual behavior and their influence on economic activity and address selection bias

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<sup>8</sup> This result differs from that of Calvo-Amengol et al. (2009) which presents evidence on the importance of an individual position in the network for their educational achievements (given by their Katz-Bonacich centrality measure).

<sup>9</sup> Friendships ties among children, especially of reciprocal nature are said to be a source of emotional support (Hartup 1996, Crosnoe et al 2003, Vaquera and Kao 2008); help to deal with problems (Azmitia and Montgomery 1993); and can also function as academic resources (Cauce 1986). The effect of popularity and social status on educational outcomes is more ambiguous. While most of the literature emphasis the fact that centrality in a peer group is usually associated with promoting students' self-esteem, since aggressive children often holds central position within their peer group, it can also promote aggression and decrease children's academic outcomes (Salmivalli et al. 1997). Research examining the different types of rejected children suggests that negative peer experiences may exacerbate academic difficulties by undermining motivation to attend school or by increasing the exposure to other marginalized peers who de-value academic success (Buhs and Ladd 2001).

problems.<sup>10</sup> The literature on social interactions in education focuses mainly on peer effects on educational outcomes. However, many of these papers are prone to severe selection bias problems. Several papers identified peer effects by investigating the implications of random assignments of college students in dormitories or classes on the students' grades (Sacerdote 2001, Zimmerman 2003, De Giorgi et al. (2010)). Alternatively, several studies have examined the effects of small changes in the characteristics of classrooms throughout the years on the average attainments of students in these classrooms (Hanushek et al. 2003, Lavy and Schlosser 2011, Lavy et al. 2012a, Lavy et al. 2012b).

Another related difficulty in the literature is the reflection problem. As explained by Manski (1993), there is a difficulty in distinguishing between the endogenous effects (how individual outcomes are affected their peers' outcomes) from the exogenous effects (the influence of the peers' exogenous characteristics). Bramoullé et al. (2009) characterize the necessary and sufficient conditions for solving this problem within the social networks framework, by examining broad social networks that include only partially overlapping groups of friends. In other words, the paper exploits networks that extend beyond a given student's immediate friends to include friends of friends, and use the characteristics of friends of friends as instrumental variable to identify the impact of the student's friends. Similarly, Lin (2010) uses detailed data on adolescents' friendships links from the National Longitudinal Study of Adolescent Health, and finds that both endogenous and exogenous effects exist in student academic attainments. In assessing to what extent early friendship choices play a role in an individual's later educational attainments (after more than 10 years), Patacchini et al. (2011) find significant effects only linked with friends in grades 10-12 but not from friends made in lower grades.

Finally, another form of social relationship that is addressed in our paper is the broad social network of the students, beyond the first circle of friends. The impact of broader forms of social interactions such as children's social networks is usually associated with the social capital embodied in networks that takes the form of more trust and cooperation among children in the network (Coleman 1988). Empirically, however, this issue had been addressed (to the best of our knowledge) only by Calvo-Amengol et al. (2009) who show that the

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<sup>10</sup> For example, many papers have investigated the importance of social interactions in explaining the way that new information is diffused (such as the diffusion of new technologies (Conley and Udry 2010) and the dissemination of information about job openings (Granovetter 1973)); patterns of risk sharing behavior (Fafchamps and Lund 2003, De Weerd and Dercon 2006); and decisions regarding education, participation in welfare programs, criminal activity, and fertility (Bertrand et al. 2000; Bayer et al. 2009).

educational outcomes of students are proportional to their position in the network, given by their Katz-Bonacich centrality measure.

### **III. Data**

#### **A. Data Sets**

In this paper we use a unique database of friendship networks of students that participated in the Tel Aviv school choice program in 2000-2004. A new school choice program started in Tel Aviv in September 1994. It replaced a busing integration program that assigned some students to schools in the city out of their school district. The choice program allowed students who completed primary school a choice of a middle school. Each student could choose from a set of five schools, three of which were outside his school district. The school choice program opened the possibility for a better match between students and schools, and the system had the potential to increase school productivity by introducing competition among schools.

Within this framework, each student, at the end of sixth grade, was asked to rank their preferred five middle schools, and to list up to eight peers with whom they would like to be assigned in middle school. In case of excess demand for enrollment in one school, students were assigned with one or more of their chosen peers to a subsequent school, so as to maintain a balanced enrollment across schools based on socio-economic level, educational achievement, gender, and disciplinary record. On average 93 percent of the students received their first school choice and most of the remaining 7 percent received their second choice. Out of the students that nominated at least one friend (94.5 percent did so), 93 percent had indeed at least one nominated friend in the same middle school and 87 percent had two such nominated friends. However, the respective means are much lower when nominated friends are counted in the same class, 82 and 61 percent.

The empirical analysis of this paper is based on the Tel Aviv municipality's administrative records of sixth-grade students in schools that participated in the Tel Aviv school choice program, for the years 2000 and 2002 and 2003. The cohort of 2001 is not included in this study because the essential data on school choice and friendships are not available.<sup>11</sup> These records contain an individual identifier, a school and class identifier in the sixth and seventh grades, sixth-grade tests scores in math, Hebrew and English (the average

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<sup>11</sup> We obtained the data from the School Authority of Tel Aviv and the files for the 2001 cohorts were erased from their archive by mistake.

grade in each subject during sixth grade), and student preferences for middle school enrollment and friend assignments.

In order to test the effect of changing a student's friendship network on their educational and social outcomes during the transition from elementary school to middle school, we combine this dataset on student social network with data from two additional sources. The first is administrative records from the Israel Ministry of Education for the three cohorts that we study. Each student's record contains their class identifier, school identifier, and demographic information (gender, ethnicity, number of siblings, and level of parents' education). The second source of data is the GEMS records (Growth and Effectiveness Measures for Schools - *Meizav* in Hebrew) collected by the Division of Evaluation and Measurement of the Ministry of Education.<sup>12</sup> This dataset includes test scores of eighth-graders from a series of tests (in math, science, Hebrew and English) and data from fifth-through ninth-grade students' surveys that include questions addressing various aspects of class environment and student behavior.<sup>13</sup>

The final merged Panel data set includes data from sixth- and eighth-grade student questionnaires, test scores for 2000-2002, 2002-2004 and 2003-2005, and student characteristics.<sup>14</sup> Table 1 presents descriptive statistics, for the size, number of schools, and number of classes for the Panel data set. We use data for the three sixth grade cohorts: 2000, 2002 and 2003. The school choice program included 42 secular primary schools and 14 secular middle schools<sup>15</sup>. Nearly every primary-school student (about 97 percent) in those schools took part of the program and listed at least one of the two preferences – the preferred school enrollment or peer assignments.<sup>16</sup> The sample included 1018 students from the 2000 cohort, 929 from the 2002 cohort, and 913 in the 2003 cohort. The table indicates that the cohorts are similar across a host of variables: parental education, average family size, and ethnicity.

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<sup>12</sup> The GEMS is not administered for school accountability purposes, and only aggregated results at the district level are published. For more information on the GEMS see the Division of Evaluation and Measurement website (in Hebrew): <http://cms.education.gov.il/educationcms/units/rama/odotrampa/odot.htm>.

<sup>13</sup> The GEMS is administered at the midterm of each school year to a representative 1-in-2 sample of all elementary and middle schools in Israel, so that each school participates in GEMS once every two years. The proportion of students tested is above 90 percent, and the rate of questionnaire completion is roughly 91 percent. The raw test scores uses a 1-to-100 scale that we transform into z-scores to facilitate interpretation of the results.

<sup>14</sup> Since every school is sampled once in two years, we observe only half of the sixth- and eighth-grade cohorts in each pair of years.

<sup>15</sup> The number of middle schools presented in the paper refers only to middle schools with GEMS test scores.

<sup>16</sup> If a student listed his or her preferred school but not his or her preferred peers (about 6 percent of the students), we assume that he did not have friends with whom he or she wanted to be with in middle school.



## **B. Definition and measurement of friendship types**

In this study we are able to distinguish between different types of friendships such as reciprocal versus non-reciprocal. In particular, our database allows us to map students' social networks in elementary schools and in middle schools (after the students' new assignments).<sup>17</sup> By using the students' peer preferences we are able to define seven different types of students' social relations: (1) self-nominated friends - students which individual  $i$  wants to be with in middle school; (2) overall followers - students who want to be with individual  $i$  in middle school; (3) reciprocal friends - the nominated friends who reciprocated with friendship nominations; (4) followers - students who nominated individual  $i$  but were not reciprocally nominated as friends by  $i$ ; (5) non-reciprocal friends - students nominated by individual  $i$  but who did not reciprocate with friendship nominations of student  $i$ ; (6) wide social network - includes all reciprocal friends of reciprocal friends and so on of student  $i$ ; and (7) narrow social network - includes only the two first circles of reciprocal friends.

Table 2 lists the descriptive statistics of these social relations at the classroom level (columns 1-3) and at the school level (columns 4-6). The table indicates that the number of reciprocal friends, followers, and non-reciprocal friends is much lower than the number of self nominated friends or overall followers since the definitions of the former take into account the reciprocal nature of the relationship. The number of self nominated and reciprocal friends in class and in school varies from zero to eight. The range in the number of overall followers is wider, from zero to 20 in sixth grade and from zero to 13 in eighth grade. The range in the size of the largest social network is from zero to 35 in sixth grade and from zero to 23 in eighth grade.

The table indicates that on average students have more reciprocal friends than either followers or non-reciprocal friends across almost all groups. For example, the number of reciprocal friends in class is 3.1 in sixth grade while the number of followers is 2.48. In addition, the table indicates that all types of friendships decline between sixth and eighth grade. For example, the number of reciprocal friends drops by about half to 1.50 in eighth grade and the same pattern is observed in the count of various friends at the school level.<sup>18</sup> The sharp decline in the number of both self nominated and reciprocal friends is due to the city authority not guaranteeing the assignment of all requested friends to the same school nor

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<sup>17</sup> It should be noted that our definition of friendships differ from the one usually used in the psychology and sociology literature that relies mainly on more direct questionnaires regarding students' social relationships.

<sup>18</sup> Another expression of these changes is the observed decline in the proportion of students who have at least one reciprocal friend in middle school. Only 84 percent of the students had at least one reciprocal friend in school and only 70 percent had at least one such friend in class whereas the respective rates in sixth grade were much higher.

to the same class. We will rely on this significant variation in number of friendships by types between sixth- and eighth-grade schools and classes when we estimate the friends' effect on students test scores. Similarly, the mean number of friends in the largest social network in class is 9.92 in sixth grade and drops sharply to 3.33 in eighth grade.

We also compare social relationships according to subgroup in Table A1. For example, the table indicates that girls have more social relationships of all kinds than boys. Younger students have fewer reciprocal friends and followers and more non-reciprocal friends than students who are in the same grade but older. Students of highly educated parents have more reciprocal friends, fewer non-reciprocal friends and considerably more followers than students of low-skilled parents. These patterns are consistent at the class level as well as at the school level.

As a final comment, we note that reciprocal friendship signals 'stronger' and more committed relationship than the other types of friendships and this is evident in the correlation of this type of friendship with preferences for schools. For example, 86 percent of a student's reciprocal friends chose the same school as their first choice, while the comparable statistic for followers is 79 percent and for non-reciprocal friends is only 70 percent.

#### **IV. Identification and Estimation**

The main goal of this paper is to estimate the effect of students' social relationships on their academic and social outcomes. As noted, the data allows us to track students from sixth grade in primary school to eighth grade in middle school. We use this feature to construct a longitudinal dataset at the student level to examine how changes in the number of friends and by types of friendships lead to changes in students' test scores and general well-being. The transition from primary to middle school is based on students' school and peer choices. Thus, the quality of middle school (resources, teachers, and other measures of real and perceived schooling quality) and the assignments of peers are endogenous. In order to resolve the potential selection bias that arises from endogeneity and omitted variables, we use an identification strategy that contrasts the change in exposure to the various type of friends from grades six to eight among students who followed the same elementary-to-middle-school transition path, and even among students who were in the same class in both sixth and eighth grades. The primary-school and middle-school fixed effects control for all the characteristics of the schools. The regression's within-class estimation, based on including sixth grade and eighth grade class fixed effects (which absorb the school wide fixed effects), also control for class-level unobserved characteristics, such as variation in teacher quality, class size,

classroom climate, and average classroom peer quality.<sup>19</sup> We will consider this model, as well as extending it to include individual fixed effects. The within-pupil estimation eliminates all unobserved characteristics that do not change between sixth and eighth grades. More formally, we assume that the cognitive achievements of pupils in grades six and eight are determined by the following equations:

$$(1) \quad y_{icjt}^8 = \alpha_i + \beta_c^8 + \delta_j^8 + \gamma_t^8 + \beta_1 RF_{icjt}^8 + \beta_2 F_{icjt}^8 + u_c^8 + \varepsilon_{icjt}^8$$

$$(2) \quad y_{icjt}^6 = \alpha_i + \beta_c^6 + \delta_j^6 + \gamma_t^6 + \beta_1 RF_{icjt}^6 + \beta_2 F_{icjt}^6 + u_c^6 + \varepsilon_{icjt}^6$$

where  $y_{icjt}$  denotes the outcome of student  $i$ , from class  $c$ , subject  $j$  and year  $t$ ;  $\alpha_i$  is the student fixed effect;  $\beta_c$  is the class/school fixed effect;  $\delta_j$  is the subject fixed effect;  $\gamma_t$  is the year fixed effect; RF is reciprocal friends; and F is for followers. We will use three measures of reciprocal friends (RF): (1) a narrower definition that includes only own reciprocal friends; (2) a very wide definition that includes all reciprocal friends in the social network.; (3) a definition that includes only the first two circles of reciprocal friends. The error term in the equation includes a school-specific random element  $u_c$  that allows for any type of correlation within observations of the same school across classes and an individual random element  $\varepsilon_{icjt}$ . Differencing equations 1 and 2 yields:

$$(3) \quad y_{icjt}^8 - y_{icjt}^6 = (\beta_c^8 - \beta_c^6) + (\delta_j^8 - \delta_j^6) + (\gamma_t^8 - \gamma_t^6) + \beta_1 (RF_{icjt}^8 - RF_{icjt}^6) + \beta_2 (F_{icjt}^8 - F_{icjt}^6) + (u_c^8 - u_c^6) + (\varepsilon_{icjt}^8 - \varepsilon_{icjt}^6)$$

The coefficients of interest are  $\beta_1$  and  $\beta_2$ , which capture the effects of the two different types of friendships. For the purpose of comparison, we will also present OLS estimates of regressions that include only cohort and subject dummies as controls and OLS estimates that also include a pupil's individual characteristic as controls, including the mother's and father's years of schooling, number of siblings, immigration status, and ethnic origin, and indicators for missing values in these covariates.

We will also present estimates from a specification where we add to equation (3) an interaction term of the primary-school and middle-school fixed effects and of the primary-

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<sup>19</sup> Students in Israel's primary and middle schools are rarely grouped into classes on the basis of ability or family background; in fact, such practices are forbidden by law. Therefore, classes in primary schools with multiple classrooms at the same grade level are typically formed on a random basis as classes are formed in a way that creates social integration by mixing students from different socioeconomic backgrounds. A 1968 education reform established a three-tier structure of schooling in Israel: primary (grades one-six), middle (seven-nine), and high (10-12). The reform established neighborhood school zoning as the basis of primary enrollment and integration, sometimes with busing of students out of their neighborhoods in middle and high school. Tracking and sorting of students in primary- and middle-school classes were outlawed, and the law is strictly enforced. Since all classes within a grade are composed of students who are on average of equal ability teachers are assigned to classes more or less randomly. As a result, the possibility of better teachers seeking to avoid assignment to lower-performing classes is irrelevant, as is the likelihood of "teacher-shopping" by parents. We note here also that the lack of tracking in primary and middle schools in Israel also rules out the possibility that class composition changes across subjects. Therefore, the students in a given class rank the same teachers.

school class and the middle-school class fixed effects. In these specifications the identification is based on students who had exactly the same transition path: in the first specification we compare students who attended the same primary and the same middle school and in the second specification students that attended the same class in primary school and the same class in middle school. Naturally, we include in each of these two specifications the respective main effects of the interaction terms and implicitly the pupil fixed effect as well. We will also test whether the estimates obtained from these additional specifications are sensitive to controlling for student's background characteristics. These sensitivity tests will provide indirect evidence about whether the change in number of different types of friendships is correlated with student's predetermined characteristics which we will also test directly by running standard balancing regressions.

## **V. Results: Effect of Types of Friendships on Academic Outcomes**

### **A. Main Results**

Table 3 reports the estimated effect of the number of friends by type of friendship on pupils' academic success according to equations 1-3. The test scores in all three subjects (math, English, and Hebrew) are pooled together, and each regression has subject and cohort fixed effects. Each estimate presented in the first four columns comes from a separate regression. We estimate the impact of reciprocal friends (column 1), followers (column 2), wide social network (column 3), and wide social network minus reciprocal friends (column 4) on academic outcomes. The last three columns (columns 5-7) show the coefficients from one joint regression that includes the number of reciprocal friends, followers, and wide social network minus reciprocal friends together. Panel A shows results at the class level and Panel B shows results at the school level. We report results for five different specifications.

The simple OLS estimates in columns 1-4 are significant for the four types of friendships, indicating that friendships have a significant and positive effect on pupil academic performance. The estimates for reciprocal friends and for followers are robust to the addition of pupil characteristics: parents' levels of schooling, number of siblings, and ethnic background. Remarkably, these estimates are also robust to adding school fixed effects or class fixed effects to the regression. In fact, comparing the estimates of these two treatments in the first row (OLS regressions without any controls) to those in the fourth row (regressions with class fixed effects and pupil characteristics) shows almost identical estimates. However, while a model that includes pupil fixed effects and class fixed effects leads to a sharp decline of about two thirds in the estimates of both reciprocal friends and followers, these estimates

still remain with the same sign and significantly different from zero. This result may suggest that the selection bias for these two measures of friendship is mainly at the pupil level.

The change in the estimates of the wide social network, with and without the first circle of reciprocal friends measure, show a different pattern as these two estimates fall sharply once we control for pupil characteristics: the effect of the wide social network falls by two thirds to 0.004 (sd=0.002) and the effect of the wide social network without the first circle of reciprocal friends even becomes negative.<sup>20</sup> However, once we add the school or the class fixed effects, these two estimates increase again to their level at the first row and are statistically significant. However, a model that includes pupil fixed effects and class fixed effects leads to a sharp decline in both estimates, and both estimates are not significantly different from zero.

In columns 5-7 of Table 3 we report estimates from regressions that include the number of reciprocal friends, followers, and the size of the wide social network (minus reciprocal friends) as treatment variables. The table indicates that the estimates for reciprocal friends and followers in columns 5 and 6 respectively are only marginally lower than the respective estimates in columns 1 and 2 despite some degree of collinearity between the two friendship measures. Similar to above, adding the pupil fixed effects changes the estimates sharply relative to the specification with class fixed effects and student characteristics. The table indicates that the estimate of reciprocal friends declines from 0.071 in the fourth specification to 0.019 when pupil fixed effects are included in the regression. This result implies that the addition of one reciprocal friend raises test scores in all three subjects by 0.019 standard deviation of the test scores distribution. This is a relatively small effect. However, if we compare two students, one without any reciprocal friends in class and a second with eight reciprocal friends in class (the maximum observed in the data in sixth or eighth grade), the latter student will experience a gain in each subject by 0.15 of a standard deviation, a boost which is non-trivial.

Furthermore, the estimate of followers declines from 0.060 in the fourth specification to 0.035 when pupil fixed effects are included in the regression. Interestingly, the estimated effect of followers is larger than that of reciprocal friends as an increase of one follower will improve test scores in all three subjects by a 0.035 standard deviation. This implies that an increase from zero followers to the mean number of followers in primary school (2.48) will improve average test scores by a 0.087 standard deviation. Similarly, an increase from zero

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<sup>20</sup> Appendix Table 2 reports these estimates for the 'narrower' social network.

followers to 15 followers (the maximum observed in primary school) will improve test scores by more than half a standard deviation, which is a dramatic difference. As an additional way to assess the overall magnitude of these estimates, we simulate how one's academic success would change if the transition to middle school did not entail changing their social circle. In other words, we model the dynamics of the circumstances as if students were able to stay with all of their childhood friends. Based on the summary statistics in Table 2, we assume the students would have on average an additional 1.60 reciprocal friends and 1.81 followers. Based on the estimates for our preferred specification with class and student fixed effects (columns 5 and 6), this scenario increases their score by 0.096 standard deviations.

The table also indicates in column 7 that the effect of the wide social network is negative and is not significantly different from zero in all specifications. This suggests that beyond the first circle of reciprocal friends, one's social network has no effect on pupil academic results. In appendix Table A2 we present estimates where we replace the 'wide' social network variable with a 'narrower' measure that only includes the first two circles of reciprocal friends. These estimates reaffirm our finding from Table 3 that any social network beyond reciprocal friends has no effect on pupil academic performance. Significantly, this result differs from that of Calvo-Amengol et al. (2009) which presents evidence on the importance of an individual position in the network, given by his Katz-Bonacich centrality measure, for his educational achievements.

In Panel B, we change the treatment variable from number of friends in class to their number in school. The table shows several interesting results. First, similar to the pattern that we found in Panel A, the estimates for the first four specifications are very stable across all columns for our school-level friendship measures. In addition, there is a sharp drop in the estimates once we add the pupil fixed effects. Second, the table shows that the estimated effect of followers on test scores is significant, and the coefficient is similar in size (0.033) to our Panel A estimate (0.038). However, the elasticity of the effect for this friendship is much lower than the respective estimate in Panel A since the mean of this treatment in school is much larger than the respective mean in class. Third, the coefficient of reciprocal friends diminishes practically to zero. One possibility for this result is that there are very small differences between sixth and eighth grades in the number of reciprocal friends in school. For example, the mean number of reciprocal friends in primary school is 3.50, and in middle school it is 2.72, a difference of only 0.78 friends in one's school. In contrast, difference in the number of reciprocal friends at the class level from elementary to middle school is 1.60. However, this does not seem to be the explanation because we also observe small differences

in the number of followers in school between sixth and eighth (1.17) grades; yet the estimated effect of this type of friendship in school remained positive and significant. Fourth, the effect of the social network measures at the school level is practically zero as was the case when we measured it at the class level. Consequently, in the rest of the paper, we will measure the social network by counting only the first circle of reciprocal friends and not include any other measure of the social network beyond this first circle.<sup>21</sup>

Non reciprocal friends are students who “rejected” the friendship offer of a student. In this section we examine whether this type of friendship has an effect on student academic achievement. Research examining the different types of rejected children suggests that negative peer experiences may exacerbate academic difficulties by undermining motivation to attend school or by increasing the exposure to other marginalized peers who de-value academic success (Buhs and Ladd 2001). We examine the effect of the three different types of friendships (reciprocal friends, followers, and non-reciprocal friends) by including each separately in a regression with different specifications and by including all three together. These estimates are presented in Table 4 and the focus of the table is on measures friendships at the class level. The estimates of reciprocal friends and of followers can be compared to the respective estimates presented in Table 3.

First, the table indicates that the pattern of how the estimates change as we vary the regression specification is very similar to what we observed in Table 3. Interestingly, the effect of non-reciprocal friends presented in columns 3 and 6 does not vary across the first four specifications, but drops sharply in our preferred specification with pupil fixed effects. Second, the table indicates that the estimates of reciprocal friends and followers are identical to the respective estimates presented in Table 3. This result implies that adding non-reciprocal friends to the regression leaves all other parameter estimates unchanged, indicating that the conditional correlations between these friendship measures are low.

The most interesting result in Table 4 is the sign and size of the effect of non-reciprocal friends. The number of non-reciprocal friends has a negative effect and its point estimate in the regressions is identical to the estimates of reciprocal friends. This pattern is identical in all five specifications. For example, the effect of non-reciprocal friends is -0.027 (sd=0.006) in column 3 and is -0.014 (sd=0.006) in column 6 in our preferred specifications.

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<sup>21</sup> We noted in the data section that 93 percent of students received their first school choice. Our results will be biased if receiving second choice affected the number of friends in school or in class and also affected test scores directly. To assess this threat for the validity of our interpretation of causal effect we estimated the models of Table 3 and Table A2 keeping in the sample only students who received their first choice school. The results are identical to those reported in the paper and are available from the authors upon request.

These two estimates almost completely offset the effect of reciprocal friends when the two friendship types (reciprocal and non-reciprocal) are measured in class. This conclusion is also correct when we compare the elasticities of these two effects since the mean of reciprocal friends in class (3.1 in sixth grade and 1.5 in eighth grade) and the mean of non-reciprocal friends in class (2.38 in sixth grade and 0.66 in eighth grade) are not very different. When we include in the regression the measure of self-defined (nominated) friends instead of the two separate measures the estimated effect is practically zero. These results are presented in columns 4-5 in Table A3. This important result can explain why studies that measured peer quality on the number of friendships without distinguishing the two types of friendships obtained zero effects for peer measures.

In Table 5, we present results of estimating equation (3) with interactions. Panel B estimates the effects of the interaction of the primary and middle school fixed effects and Panel C estimates the effects of the interaction of the primary class fixed effects and the middle school class fixed effects. In both of these respective panels, the first difference specification accounts for the pupil's fixed effect. In each panel we report results from two specifications, without and with controls for pupil's background characteristics. In all the regressions for the table we include only the classroom level of reciprocal friends (column 1), followers (column 2), and both (columns 3 and 4) as treatment variables. We exclude the broader measures of the friendship network due to our Table 3 results which suggested that they have no effect on test outcomes. As well, the effects for our other friendship measures are not sensitive to this exclusion.

In order to better assess the impact of our interaction terms, Panel A presents our baseline results (an estimate of equation (3)) without any of the interaction terms. The effect of both friendship types are identical to the respective estimates presented in Table 3, where the effect of reciprocal friends on test scores is 0.018 (sd=0.007) and for followers is 0.035 (sd=0.006) for our preferred specification.<sup>22</sup> Adding the interaction term for primary and middle school fixed effects in the first row of Panel B leaves the original estimates almost unchanged, where the effect of reciprocal friends on test scores is 0.017 (sd=0.008) and for followers is 0.031 (sd=0.005). Similarly, controlling for pupil characteristics leaves these two estimates almost unchanged (second row of Panel B). As well, the results in Panel C are very

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<sup>22</sup> This is another indication that including or excluding the social network measure from the regression does not affect at all the estimates of reciprocal friends and followers.



similar to our Panel B results, which indicates that the class interaction terms have only a marginal effect on our baseline results.<sup>23</sup>

The results in Table 5 are significant for two reasons. First, the table indicates that the interaction terms had no significant effect on our results. This implies that there is no need to base our estimates on a comparison of students who attended the same school or class in primary school and the same school or class in middle school. Second, the table indicates that our results were unaffected by controlling for student characteristics. This implies that changes in the number of friends or the types of friendships are not correlated with student characteristics. In other words, there is no selection bias due to any correlation between the treatment measures and observable characteristics of students that are highly correlated with potential outcomes of students.

In Table 6, we present additional evidence regarding this important threat to our identification strategy. In particular, the table presents "balancing tests" for the number and different types of friends in class where we regresses directly student characteristics on the treatment measures. We examine seven student characteristics: gender, number of siblings, father's years of education, mother's years of education, and three ethnicity indicators (child or parents born in Asia/Africa, Europe/America, or in Israel). The estimates presented in the tables are the regression coefficients of each of these student characteristics on the number of friends of a given type. We include as controls the cohort, primary and middle school class fixed effects, and their interaction. Each column presents estimates for one of the following friendship types: self-nominated friends, reciprocal friends, followers, non-reciprocal friends, wide social network, and narrow social network.

Overall, the table indicates that there is no evidence of a relationship between these characteristics and the change in number of friends of each type. First, there are 42 estimates presented in Table 6 and only 3 are significant or marginally significant. Second, regarding the two main friendship types that we use in Table 5 (reciprocal friends and followers), only father's year of schooling for followers is significant and "unbalanced" (column 3). In combination with our Table 5 results, the overall evidence suggests that there is no systematic imbalance in the relationship between student characteristics and the change in the number of friends between sixth and eighth grade.

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<sup>23</sup> It should be noted that one notable difference between the panels is that the effect of reciprocal friends on test scores 0.029 (sd=0.012) is larger in Panel C than in Panels A and B. However, this difference most likely reflects differences in the sample size as there are relatively few students in the sample who advanced from the same class in primary school to the same class in middle school.

## B. Results Based on an Alternative Identification Strategy

In the previous section, the main potential limitation of the identification strategy is that the number of middle-school reciprocal friends might be a function of the number of primary-school friends. In order to explicitly control for the effect of these lagged friendships, in this section, we estimate a model with eighth-grade test scores as the dependent variable and the number of friends by type in eighth grade as our treatment variable. At the same time, we will control for the number of sixth-grade friends by type, for sixth-grade test scores, as well as for individual characteristics, school fixed effects, and class fixed effects.<sup>24</sup> We estimate the following model:

$$(4) \ y_{icjt}^8 = \beta_c^8 + \delta_j^8 + \gamma_j^8 + \beta_1 RF_{icjt}^8 + \eta_1 RF_{icjt}^6 + \beta_2 F_{icjt}^8 + \eta_2 F_{icjt}^6 + \lambda y_{icjt}^6 + \phi X_{icjt} + u_c^8 + \varepsilon_{icjt}^8$$

where  $X_{icjt}$  denotes characteristics of student  $i$ , from class  $c$ , subject  $j$  and year  $t$ . The coefficients of interest are  $\beta_1$  and  $\beta_2$ . The identification strategy here is selection based on observables. The identification assumption is that conditional on class and subject fixed effects, sixth-grade test scores, student characteristics, and the number of sixth-grade friendships by type, the number of friends in eighth grade can be considered randomly assigned.

In Table 7 we report estimates for equation (4), our alternative identification strategy. In columns 1-4, we report estimates from one joint regression for the impact of the number of reciprocal friends and followers on eighth grade test scores. The table reports estimates for the following specifications: (1) OLS regression models with no controls (except subject and cohort dummies); (2) models with lagged controls; (3) models with pupil characteristics; (4) models with school fixed effects; and (5) models with class fixed effects. In the sixth row, we report estimates from a regression where we add lagged sixth-grade test scores as controls.

The estimates in column 1 show that reciprocal friends have a positive effect on test scores, and the simple OLS estimate is 0.108. The estimate declines only marginally to 0.091 after controlling for the number of sixth-grade friendships. However, the estimate drops sharply to 0.044 when we add student characteristics as controls. Adding school or class fixed effects leaves the estimate practically unchanged, but adding the sixth-grade test score lowers the estimate slightly to 0.038. Note that this estimate is about twice the estimate reported in Table 3 (0.018). Significantly, the sensitivity of our estimate of reciprocal friends to student characteristics and lagged test scores is an indication that we cannot exclusively rely on the

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<sup>24</sup> Even though this model utilizes only the cross section data for eighth grade, it is still possible to use school and class fixed effects since the treatments vary by student.

cross section regression model in identifying the effect of reciprocal friends on test scores. In column 2, we also control for lagged sixth-grade test scores. The results of the last specification imply that the effect of sixth-grade reciprocal friends (which was seen as marginal above) is nearly zero (0.007).

Furthermore, while the pattern of the estimated effect of followers from the first to the fifth specification in column 3 is somewhat different than the pattern for the estimated effect of reciprocal friends, the end result is similar: the estimated effect of eighth-grade followers on eighth-grade test scores is positive and significant. Interestingly, the effect of followers on test scores in this table (0.031) is very similar to the respective estimated effect presented in Table 4 (0.035), and the standard deviation errors of these two estimates are also very similar.

Overall, the results from Table 7 do not rule out the possibility that the number of middle-school reciprocal friends and followers might still be correlated with students' unobservables. We therefore consider an alternative identification strategy that is based on a model which yields a value added equation (the change in test score between sixth and eighth grades) that is conditional on the number of friends in primary school. Assuming that the test scores for sixth grade students are only a function of the current number of the two different types of friendships, we consider the following model:

$$(5) \quad y_{icjt}^6 = \alpha_i + \beta_c^6 + \delta_j^6 + \gamma_t^6 + \beta_1 RF_{icjt}^6 + \beta_2 F_{icjt}^6 + u_c^6 + \varepsilon_{icjt}^6$$

In this equation, test scores in sixth grade are not dependent on previous friends since we are assuming that primary school is the initial period where students develop school childhood friendships. However, we do allow for childhood friendships formed during primary school to have an effect on academic performance during middle school. We then specify the following relationship for eighth grade where all terms in the equation have the same notation as in the sixth-grade equation:

$$(6) \quad y_{icjt}^8 = \alpha_i + \beta_c^8 + \delta_j^8 + \gamma_t^8 + \beta_1 RF_{icjt}^8 + \beta_2 F_{icjt}^8 + \delta_1 RF_{icjt}^6 + \delta_2 RF_{icjt}^6 + u_c^8 + \varepsilon_{icjt}^8$$

$$(7) \quad y_{icjt}^8 - y_{icjt}^6 = (\beta_c^8 - \beta_c^6) + (\delta_j^8 - \delta_j^6) + (\gamma_t^8 - \gamma_t^6) + \beta_1 RF_{icjt}^8 + (\delta_1 - \beta_1) RF_{icjt}^6 + \beta_2 F_{icjt}^8 + (\delta_2 - \beta_2) F_{icjt}^6 + (u_c^8 - u_c^6) + (\varepsilon_{icjt}^8 - \varepsilon_{icjt}^6)$$

This equation leads to a regression specification with both current and lagged number of friendships by type as determinants of test score value added between sixth and eighth grades. Assuming that student characteristics remains constant between the two grades, the student's fixed effect term is dropped from equation (7) by the difference operator as does the subject fixed effects. However, the class or school fixed effects are included in equation (7) since the students are in two different classes (or schools) in the two grades. Notably, the

main difference between equation (7) and equation (3) (our main model) is that equation (7) allows for the effects of current and lagged friendships to be different.

In Table 8 we report estimates for equation (7). Columns 1-2 present the estimates in which each type of friendship is used separately in the regression. In columns 3-4 we present estimates in which eighth grade reciprocal friends and followers are included jointly in the regression. In column 1, the OLS estimate is 0.041, and it drops to 0.016 after student characteristics are added to the regression. Adding school or class fixed effects only changes the estimate marginally. For example, with class fixed effects the results of reciprocal friends on value added test scores is 0.028 (sd=0.009). In column 2, the estimates show a different pattern with little variation from the simple OLS estimate (0.038) to the class fixed effect estimate (0.041). The results in columns 3-4 follow approximately the same pattern of the estimates presented in columns 1-2 with respect to the effect of the variation in specification on the point estimates. Furthermore, the estimates in column 3-4 for our class fixed effect specification are nearly identical to the respective estimates in columns 1-2. However, the most remarkable result in Table 8 is that the effect of reciprocal friends and followers based on our preferred specification (with class fixed effects, student characteristics and sixth-grade measures of friendships) are identical to the respective estimates in Table 5 based on pupil and the class primary and middle school class fixed effects and their interaction fixed effect. For example, the effect of reciprocal friendships on test scores in the table is 0.025, while the respective estimate in Table 5 is 0.029. Similarly, the effect of followers on test scores in the table is 0.031, while the respective estimate in Table 5 is 0.032. Remarkably, two alternative identification models with different assumptions lead to the same results. The similar results in both Tables 5 and 8 mutually endorse our findings, giving us additional confidence that our results and our identification of the mechanisms at work are accurate.

### **C. Estimated Effects by Subject**

The results reported in the previous sections assumed that the effect of each of the friendships types is the same in all subjects. In this section, we test this assumption by considering the effect of each of the friendships on each subject separately. In Table A4, we present evidence that is based on estimating a separate regression for each subject, using the full specified regression that includes class fixed effects and pupil fixed effects. The results are remarkably similar across subjects at the class level. For example, the estimated effects of reciprocal friends in class on test scores are 0.017 for math, 0.024 for Hebrew, and 0.013 for English. While the subject-specific estimates are naturally less precise than our pooled estimates, each of these three estimates is close to the average estimate (0.018) obtained in

our Table 5 estimates (column 3, second row) when all the subjects were pooled together. Similarly, the table indicates that estimated effects of followers on test scores – 0.039 for math, 0.033 for Hebrew, and 0.032 for English – are similar to the average estimate (0.035) obtained for followers in our Table 5 estimates. Overall, these results suggest that the effect of each type of friend is similar across subjects.

#### **D. Nonlinear Effects**

In this section, we consider the nonlinear effects of friends. These results are motivated by the following questions: how large does the social network of reciprocal friends and of followers need to be in order to have a meaningful effect on students? Is there a threshold of a minimum number of friends needed in order to impact academic achievements? We parameterize nonlinear effects of friendship by transforming the continuous measures of number of friends into seven dummy indicators. Our dummies are based on the number of reciprocal friends where the first indicator is a dummy variable for students with zero friends; the second indicator is for students with one reciprocal friend; and so on until the seventh indicator for students with six or more such friends. A similar set of seven dummies is defined for the number of followers.

In Table A5 we present estimates for the non-linear effects of these two sets of friendships. In columns 1-2, friendship is measured at the class level and in columns 3-4 friendship is measured at the school level. The estimates are based on a specification with class and pupil fixed effects with the dummy variable for not having any friends eliminated. The table indicates that not all of the estimates in column 1 are statistically significant. Therefore, it is difficult to determine whether that the effect of reciprocal friends is linear. The estimates of the effect of followers suggest stronger evidence for linear effects. However, the pattern of change of the estimates is irregular. For example, there seems to be a 'jump' in the estimates at two points: when one shifts from three to four friends and again when one has six or more friends. The estimates in columns 3-4 present are more mixed. For example, the coefficients of reciprocal friends fluctuate in sign and none is significantly different from zero. Similarly, the effect of followers in school is positive only from three and more such friends, which may suggest some nonlinearity. Overall, the evidence seems to suggest that the effect of reciprocal friends and followers on test scores is partially nonlinear.

#### **E. Heterogeneous Treatment Effects of Friendships on Test Scores**

In order to gain more insight on the effects of friendship on students' test scores, in this section, we explore the heterogeneous effects of friendships across different dimensions. In Table 9 we present estimates based on three different stratifications of the full sample, using

our preferred specification that includes class fixed effects and pupil fixed effects. Panel A reports the heterogeneous treatment effects of friendship types by gender and Panel B reports results separately by father's years of schooling (above and below the median – 13 years).<sup>25</sup> Panel C presents evidence separately for young and older children of a given cohort.<sup>26</sup>

Interestingly, Panel A suggests that the respective estimates for boys and girls are very similar. The table suggests that while the effect of reciprocal friends is slightly higher for girls than for boys (0.030 versus 0.021), the difference between the two estimates are not statistically different. Similarly, the estimated effect of followers in class is nearly the same for both genders (0.037 versus 0.036). Panel B suggests that the effects of friendship types are generally larger for the students with low levels of parental education. For example, the effect of reciprocal friends is 0.017 (sd=0.010) for students from families with low levels of education and only 0.010 (sd=0.011) for students from families with high levels of education. Similarly, the effect of followers upon students from families with low levels of education is also almost twice as large then the effect on students from families with high levels of education (0.045 (sd=0.009) versus 0.024 (sd=0.008)). This suggests that the social network of friendships is more important for children from lower socioeconomic status. One explanation for this result may be that for students whose parents have low education levels, friends might be the principal source of information for academic decisions and for motivation and involvement in school (Crosnoe 2002, Crosnoe et al. 2003).

Panel C presents the estimates for the heterogeneity of peer effect by age of pupils. The “young” group includes pupils born in the later part of the cohort year (from July to December) while the “old” group includes pupils born in the earlier part of the cohort year (from January to June). This approach may be uncommon, but we posit that the relative age within a classroom may be significant. Indeed, the table indicates that there are large and interesting heterogeneous treatment effects by age. The table indicates that the effect of reciprocal friends in the classroom is positive and significant for the younger students. In contrast, the effect of reciprocal friends for the older students is not significant. Similarly, the effect of followers is positive and large for the younger students. While the effects are also

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<sup>25</sup> Students with missing values in parental education (4 percent of the total sample) are excluded from this analysis. The results are not sensitive to the inclusion of these students in the low or high education group. Results based on stratifying the sample by mother's schooling are very similar to those based on father's schooling. These results are available from the authors upon request.

<sup>26</sup> It should be noted that an alternative way to measure heterogeneous effects would have been to use interaction terms for these subgroups. However, in this type of approach, the treatment-interaction terms may pick up variations by gender or parental schooling in the effects of other covariates included in the regressions. For this reason, we choose to stratify our sample, although this means our estimates are based on a smaller sample.

positive and significant for the older students, the effects are stronger among the younger students (0.041 versus 0.022).<sup>27</sup>

As a concluding remark for this section, it is important to note that the evidence about the heterogeneous treatment effects of the different friendship types is also important from an identification perspective. As noted in the data section, classes within schools are formed randomly with respect to parental schooling, student's gender, and age. For this reason, any unaccounted-for sorting or selection of the number of friends by type and across classes within schools should not be differentiated by gender, parental schooling, or by age.<sup>28</sup> Thus, our table 8 results suggest that differential effects by gender, parental-schooling, and age is another indication that potential omitted selections or sorting factors (as well as the possibility of endogeneity of the number of friends by type) cannot account for the results we present in this paper.<sup>29</sup>

## **F. Effect of Quality of Reciprocal Friends**

In this section we examine whether the quality of reciprocal friends in terms of their family socioeconomic status has an effect on student achievements. Previous studies that estimated peer effects have used different friends' characteristics as measures of their quality. For example, Ammermueller and Pischke (2009) used the number of books at home as proxies for parental schooling levels and Lavy et al. (2012b) used grade repeating as one quality determinant. Similarly, Lavy, et al. (2012a) used the proportion of low and high achievers in one's school environment, and Hanushek et al. (2003) used lagged measures of peer achievements. In this paper we use the mean of the father's or mother's years of schooling among reciprocal friends as a measure of the quality for this type of friend.

In columns 1 and 2 of Table 10 we present estimates of the effect of these two education measures when each is used separately in the regressions with a varying degree of additional controls, from a simple OLS to the specification that includes class and pupil fixed effects. The estimates are very similar in the first four specifications. In the fifth specification, with class and pupil effects, only the estimate of father's schooling is statistically significant

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<sup>27</sup> We also tried a variation in which we divided the "old" into two groups: those born within the cohort year, and those older. However, the results were very similar for these two groups. These results are available from the authors upon request.

<sup>28</sup> We also estimated the heterogeneous effects while including non reciprocal friends as a treatment measure. All estimates of this type of friendship were negative though the size of the effect varied by sub-groups. These results are available from the authors.

<sup>29</sup> This conclusion is also supported by the lack of any systematic relationship between the changes in the number of friends by type and student's background characteristics. These balancing tests for each of these sub-samples are not presented in the paper and are available from the authors upon request.

and it is double the size than the estimate for mother's years of schooling, 0.011 (sd=0.006) versus 0.005 (sd=0.007). We therefore decided to use the mean of the father's years of schooling among reciprocal friends as a measure of quality for this friendship group in the joint regression.

In columns 3-5 of Table 10 we presents the estimates of the effect of reciprocal and follower friendships on test scores in regressions that include the quality of reciprocal friends (as measured by the mean years of schooling among their fathers). The table indicates that the estimates in column 3 are almost identical to those in column 1, implying that the education level of the fathers for reciprocal friends is not highly correlated with each of the two types of friendships. For example, our preferred specification with class and pupil fixed effects indicates that the effect of this quality measure on test scores is 0.010 (sd=0.006) in column 3 versus 0.011 (sd=0.006) in column 1. The table also indicates that the effect of the two friendship types is similar to those reported in columns 4-5 of Table 3. For example, the effect of followers in column 5 is 0.035 (sd=0.006), which is identical to the respective estimates in Table 3. Similarly, the effect of reciprocal friends in column 4 is 0.017 (sd=0.007) versus 0.018 (sd=0.007) in Table 3. Overall, these results offer additional support for our core results.

In Panel B, we present estimates for our preferred specification with class and pupil fixed effects at the school level rather than at the classroom level. Columns 1 and 2 indicate that the effect of the mean levels of education for the fathers and mothers of reciprocal friends at the school level are very similar. However, the effect is less pronounced than our Panel A estimates. Similarly, column 3 reports similar estimates to our estimate at the classroom level. The table also indicates that the effect of the number of reciprocal friends in class is not statistically different from zero (0.007, sd=0.011) and the effect of followers is similar to our Panel A results (0.032, sd=0.008) and precisely measured. As well, both of these estimates are similar to the equivalent estimates reported in Table 3. Overall, the results suggest that reciprocal friends have an impact in class but not in school, but followers are important both in class and in school.

### **G. Effect of Types of Friendships on Behavioral Outcomes**

In this section, we consider the effects of friendship on behavioral outcomes. This analysis is based on the following four questionnaire items<sup>30</sup>: (1) "I was involved in violence (physical fights) in school many times this year"; (2) "Sometimes I'm scared to go to school

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<sup>30</sup> In these questions, students are asked about the extent to which they agree with a series of statements by using six-point scale ranging from 1 (strongly agree) to 6 (strongly disagree).



because there are violent students”; (3) “I feel well-adjusted socially in my class”; (4) “I am satisfied in school”. The students also report the time spent (in weekly hours) doing homework in each of the four subjects, and we use the reported total number of weekly hours spent on homework in all subjects as one of our outcomes.

In Table 11 we report estimates of the effect of reciprocal friends and followers on each of the five behavioral outcomes. We report estimates from a regression that includes each friendship type separately (columns 1-2) and from a regression that included the two treatments jointly (columns 3-4). Panel A reports estimates from a specification that includes class and pupil fixed effects and Panel B presents the estimates from a simple OLS regression without any controls except year dummies.

The estimates in Panel A of Table 11 suggest that the presence of more friends in the classroom reduces fear and intimidation from school violence and bullying and improves social satisfaction and school satisfaction. However, the number of friends does not have any discernible effect on personal involvement in violence in school or on homework. Focusing on the results in columns 3-4, we see that the effect of followers is significant for three outcomes: intimidation from school violence (-0.048,  $sd=0.020$ ), social satisfaction (0.064,  $sd=0.020$ ) and school satisfaction (0.034,  $sd=0.019$ ). The estimated effects of reciprocal friends has the same signs as the effect of followers, but only its effect on overall satisfaction from school is statistically significant (0.055,  $sd=0.025$ ). Note that although the estimates presented in columns 1-2 (obtained from regressions with each treatment entered separately) reveal the same pattern as that of the estimates in columns 3-4, the estimates are generally much larger. Similarly, the OLS estimates presented in Panel B of Table 10 are relatively larger, an indication that they are highly biased upward.

In Table 12, we examine whether the effects of friendship types on behavioral outcomes vary by gender. The evidence suggests that boys are affected more by the number of friends. For example, the table suggests that followers reduce boy's violent behavior (-0.076,  $sd=0.036$ ) fear of school violence (-0.047,  $sd=0.033$ ), improves sharply social satisfaction (0.070,  $sd=0.031$ ) and school satisfaction (0.096,  $sd=0.031$ ). As well, the effect of reciprocal friends on boys has a similar pattern, although the only significant results is the effects on school satisfaction (0.081,  $sd=0.042$ ). Relative to these effects on boys, the effects of reciprocal friends and followers on girls are much less clear, and no clear pattern emerges.

## VI. Conclusions

In this paper we study the effect of a student's social relationships in class and in school on their educational achievement and social well-being. For our research, we are able to take advantage of a unique dataset from a Tel Aviv school choice program that allows us to analyze the students' social networks as they are undergoing a major transition from elementary to middle schools. This transition enables us to overcome potential selection bias that results from the students' school and friendship choices during the application process by using fixed-effect methodology. Using an alternative estimation strategy, based on cross section data of eighth grade students that control for sixth grade's test score and number of friendship by type, reinforces our main findings.

Our results suggest that the presence of reciprocal friends and followers in class has a positive and significant effect on test scores in English, math and Hebrew, while non-reciprocal friends has an opposite (negative) effect. However, beyond the first circle of reciprocal friends, the effect of the rest of the social network has no effect on students' academic performance. To assess the overall magnitude of the effect size of these estimates we simulate how one's academic success would change if the transition to middle school did not entail changing their social circle. We find that if on average students have the same number of friends at class and school as they had in primary school it would have increased their score by 0.056 of a standard deviation.<sup>31</sup> Alternatively, if we refer only to the impact of reciprocal friends, it would have increased the student's grade by 0.043 of a standard deviation. We also found that friendships were more important for girls, students with low parental schooling, and young students relative to their age cohort.<sup>32</sup> Our results also suggest that the effects of these various types of friendships are also important for the general well-being of students. The presence of more friends of any type in the classroom reduces fear and intimidation from school violence and bullying, and improves social satisfaction and school satisfaction.

The evidence we present is relevant for education policy makers, in particular with regard for the design of school choice program. Since our study addresses the importance of students' social relationships on academic achievement and general well-being, the research

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<sup>31</sup> This estimate is based on the summary statistics in Table 2 which indicates that students would have on average an additional 1.60 reciprocal friends, 1.80 followers, and 1.72 non-reciprocal friends.

<sup>32</sup> It should be noted that this simulation addresses only the direct effect of social relations, though other studies suggest that there might be additional positive peers effects at the classroom level that result from the better educational performance of peers (see (Lin 2010), (De Giorgi et al.2010)).

has the potential to improve the way students are assigned among and within schools, and advance our understanding of the social dynamics implicit in school choice programs.

## VI. References

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**Table 1: Summary Statistics of Students' Characteristics by Cohort**

	<b>2000</b>	<b>2002</b>	<b>2003</b>
	(1)	(2)	(3)
Mean Father's Education	13.38 (3.55)	13.42 (3.37)	12.70 (3.43)
Mean Mother's Education	13.74 (3.10)	13.73 (3.11)	13.08 (2.99)
Mean Number of Siblings	2.06 (1.18)	2.08 (1.03)	2.28 (1.11)
Proportion of Asia/Africa Ethnicity	0.13 (0.34)	0.11 (0.31)	0.11 (0.31)
Proportion of Europe/America Ethnicity	0.19 (0.39)	0.20 (0.40)	0.19 (0.39)
Proportion of Israel Ethnicity	0.57 (0.49)	0.57 (0.49)	0.61 (0.49)
Number of Students	1018	929	913
Number of Elementary Schools	42	38	37
Number of Elementary Classes	83	73	76
Number of Middle Schools	6	8	7
Number of Middle School Classes	34	32	37

Notes: Each column is based on a different cohort. Standard deviations are reported in parentheses.

**Table 2: Descriptive Statistics of the Social Network:  
Number of Friends by Type in Class and in School**

	In Class			In School		
	Mean (1)	Min (2)	Max (3)	Mean (4)	Min (5)	Max (6)
<b>1. Sixth Grade</b>						
A. Self nominated friends	5.48 (2.54)	0	8	6.49 (2.68)	0	8
B. Overall followers	5.59 (3.72)	0	20	6.63 (4.09)	0	26
C. Reciprocal friends	3.10 (2.23)	0	8	3.50 (2.34)	0	8
D. Followers	2.48 (2.35)	0	13	3.13 (2.92)	0	20
E. Non-reciprocal friends	2.38 (2.14)	0	8	2.99 (2.30)	0	8
F. Wide social network minus reciprocal friends	9.92 (8.83)	0	35	19.73 (27.48)	0	106
G. Narrow social network minus reciprocal friends	3.60 (3.11)	0	18	4.93 (4.01)	0	26
N	8580					
<b>2. Eighth Grade</b>						
A. Self nominated friends	2.16 (1.78)	0	8	4.64 (2.68)	0	8
B. Overall followers	2.17 (2.04)	0	13	4.68 (4.09)	0	23
C. Reciprocal friends	1.50 (1.52)	0	8	2.72 (2.22)	0	8
D. Followers	0.68 (1.05)	0	8	1.96 (2.40)	0	17
E. Non-reciprocal friends	0.66 (1.07)	0	7	1.92 (1.99)	0	8
F. Wide social network minus reciprocal friends	3.33 (3.83)	0	23	11.88 (19.11)	0	75
G. Narrow social network minus reciprocal friends	1.09 (1.39)	0	9	3.48 (3.53)	0	21
N	8580					

Notes: The figures in the table denote the number of friends in each category. Self nominated friends (group A) includes the nominated students the student asked to be with in middle school. Overall followers (group B) include students who asked to be with student in middle school. Reciprocal friends (group C) is the intersection of A and B. Followers (group D) is B-C. Non-reciprocal friends (group E) is A-C. Wide social network friends minus reciprocal friends (Group F) includes all reciprocal friends of friends and so on, excluding the first circle of reciprocal friends. Narrow social network minus reciprocal friends (group G) includes only the second circle of reciprocal friends. Standard deviations are reported in parentheses.



**Table 3: Estimated Effect of Number of Reciprocal Friends, Followers, and Wide Social Network on Test Scores in Math, English, and Hebrew**

	Treatments included separately				Treatments included jointly		
	Reciprocal Friends (1)	Followers (2)	Wide Social Network (3)	Wide Social Network minus Reciprocal Friends (4)	Reciprocal Friends (5)	Followers (6)	Wide Social Network minus Reciprocal Friends (7)
<b>A. Class Level Treatments</b>							
OLS	0.088 (0.007)	0.077 (0.006)	0.011 (0.002)	0.007 (0.002)	0.075 (0.007)	0.057 (0.006)	-0.002 (0.002)
OLS with Pupil Characteristics	0.072 (0.007)	0.067 (0.006)	0.004 (0.002)	-0.002 (0.002)	0.067 (0.007)	0.055 (0.006)	-0.010 (0.002)
School Fixed Effect	0.083 (0.004)	0.075 (0.004)	0.011 (0.001)	0.005 (0.001)	0.070 (0.004)	0.057 (0.004)	-0.003 (0.001)
Class Fixed Effect	0.086 (0.004)	0.078 (0.004)	0.015 (0.001)	0.006 (0.002)	0.071 (0.004)	0.060 (0.004)	-0.003 (0.002)
Class and Pupil Fixed Effects	0.027 (0.007)	0.038 (0.006)	0.003 (0.002)	0.001 (0.002)	<b>0.018</b> (0.007)	0.035 (0.006)	-0.002 (0.002)
	15506						
<b>B. School Level Treatments</b>							
OLS	0.064 (0.006)	0.049 (0.004)	0.003 (0.001)	0.003 (0.001)	0.047 (0.006)	0.032 (0.005)	0.001 (0.001)
OLS with Pupil Characteristics	0.052 (0.006)	0.041 (0.004)	0.000 (0.001)	0.000 (0.001)	0.041 (0.006)	0.029 (0.004)	-0.001 (0.001)
School Fixed Effect	0.058 (0.003)	0.042 (0.003)	0.002 (0.001)	0.003 (0.001)	0.046 (0.004)	0.027 (0.003)	0.000 (0.001)
Class Fixed Effect	0.059 (0.004)	0.043 (0.003)	0.002 (0.001)	0.003 (0.001)	0.045 (0.004)	0.030 (0.003)	0.000 (0.001)
Class and Pupil Fixed Effects	0.015 (0.010)	0.033 (0.008)	0.000 (0.002)	0.000 (0.001)	0.007 (0.011)	0.032 (0.008)	-0.001 (0.001)
N	15506						

Notes: The OLS specification includes only year dummies and cohorts dummies as controls. Pupil's characteristics includes gender, parental education, number of siblings, and dummies for five ethnicity groups. Standard errors are clustered by class and are reported in parentheses. The estimates in columns 1-4 are each from a separate regression. The estimates in each row in columns 5-7 are from the same regression.

**Table 4: Estimated Effect of Number of Reciprocal Friends, Followers, and Non-Reciprocal Friends on Test Scores in Math, English, and Hebrew**

	Treatments included separately			Treatments included jointly		
	Reciprocal Friends (1)	Followers (2)	Non-Reciprocal Friends (3)	Reciprocal Friends (4)	Followers (5)	Non-Reciprocal Friends (6)
<b>A. Class Level Treatments</b>						
OLS	0.088 (0.007)	0.077 (0.006)	-0.079 (0.007)	0.064 (0.007)	0.047 (0.006)	-0.046 (0.008)
OLS with Pupil Characteristics	0.072 (0.007)	0.067 (0.006)	-0.078 (0.007)	0.049 (0.007)	0.042 (0.006)	-0.051 (0.008)
School Fixed Effect	0.083 (0.004)	0.075 (0.004)	-0.081 (0.004)	0.058 (0.004)	0.046 (0.004)	-0.045 (0.005)
Class Fixed Effect	0.086 (0.004)	0.078 (0.004)	-0.082 (0.005)	0.059 (0.005)	0.047 (0.005)	-0.042 (0.005)
Class and Pupil Fixed Effects	0.027 (0.007)	0.038 (0.006)	-0.027 (0.006)	0.015 (0.007)	0.031 (0.006)	-0.014 (0.006)
N	15506					

Notes: See Table 3. The estimates in columns 1-3 are each from a separate regression. The estimates in each row in columns 4-6 are from the same regression.

**Table 5: Estimated Effect of Number of Reciprocal Friends and Followers in Class on Test Scores in Math, English, and Hebrew**

	<u>Treatments included separately</u>		<u>Treatments included jointly</u>	
	Reciprocal Friends (1)	Followers (2)	Reciprocal Friends (3)	Followers (4)
<b>A. Class Fixed Effect Specification</b>				
Class Fixed Effect	0.086 (0.004)	0.078 (0.004)	0.070 (0.004)	0.059 (0.004)
Class and Pupil Fixed Effects	0.027 (0.007)	0.038 (0.006)	0.018 (0.007)	0.035 (0.006)
N	15506			
<b>B. First Difference Specification with Primary and Middle School Fixed Effects and their Interactions</b>				
No Additional controls	0.025 (0.008)	0.034 (0.005)	0.017 (0.008)	0.031 (0.005)
Controls: Pupil Characteristics	0.024 (0.008)	0.032 (0.005)	0.016 (0.008)	0.029 (0.005)
N	7746			
<b>C. First Difference Specification with Primary and Middle School Class Fixed Effects and their Interaction</b>				
No Additional controls	0.038 (0.011)	0.039 (0.007)	0.030 (0.012)	0.034 (0.007)
Controls: Pupil Characteristics	0.037 (0.011)	0.037 (0.006)	0.029 (0.012)	0.032 (0.007)
N	7746			

Notes: See Table 3. The estimates in columns 1-2 are each from a separate regression. The estimates in each row in columns 3-4 are from the same regression. The School Fixed Effects Interactions includes interaction fixed effects between elementary schools and middle schools. The Class Fixed Effects Interactions includes interaction fixed effects between elementary classes and middle school classes.

**Table 6: Balancing Estimates of Student Characteristics of Changes in Number of Friends (By Type) in Class, Between Eighth and Sixth Grades, Full Sample**

	Self Nominated Friends	Reciprocal Friends	Followers	Non Reciprocal Friends	Wide Social Network	Narrow Social Network
	(1)	(2)	(3)	(4)	(5)	(6)
Gender (Boy = 1)	0.183 (0.182)	0.019 (0.127)	-0.041 (0.123)	0.164 (0.123)	-0.252 (0.530)	0.104 (0.343)
Number of siblings	-0.020 (0.054)	-0.017 (0.035)	-0.037 (0.041)	-0.003 (0.052)	-0.238 (0.131)	-0.134 (0.063)
Father's years of schooling	-0.011 (0.015)	0.001 (0.012)	0.031 (0.014)	-0.012 (0.014)	0.045 (0.051)	0.017 (0.025)
Mother's years of schooling	-0.028 (0.022)	-0.017 (0.015)	0.003 (0.016)	-0.011 (0.015)	-0.006 (0.043)	-0.015 (0.033)
Ethnicity Asia/Africa	-0.077 (0.139)	-0.030 (0.121)	0.208 (0.149)	-0.048 (0.105)	0.104 (0.333)	-0.159 (0.249)
Ethnicity Europe/America	-0.059 (0.145)	0.016 (0.107)	0.006 (0.134)	-0.075 (0.112)	0.186 (0.445)	0.153 (0.237)
Ethnicity Israel	0.097 (0.115)	0.120 (0.086)	0.080 (0.102)	-0.023 (0.095)	-0.075 (0.378)	0.214 (0.182)
N	2858	2858	2858	2858	2858	2858

Notes: Each regression includes cohort fixed effects and interaction fixed effects between elementary class and middle school class. Standard errors are clustered at the primary school level and reported in parentheses.

**Table 7: Estimated Effect of Reciprocal Friends and Followers from a Cross Section  
Regression of Eighth Grade Test Scores**

	Two Main Treatments Included Jointly				
	Reciprocal Friends		Followers		Lagged Score
	Main Treatment	Lagged Treatment	Main Treatment	Lagged Treatment	
(1)	(2)	(3)	(4)	(5)	
OLS	0.108 (0.011)		0.058 0.016		
OLS with lagged treatment	0.091 (0.015)	0.013 (0.012)	0.016 (0.020)	0.036 (0.010)	
Pupil characteristics	0.045 (0.013)	0.025 (0.010)	0.013 (0.017)	0.030 (0.008)	
School Fixed Effect	0.050 (0.009)	0.028 (0.006)	0.023 (0.012)	0.021 (0.005)	
Class Fixed Effect	0.056 (0.009)	0.026 (0.006)	0.027 (0.012)	0.016 (0.005)	
Lagged Score	0.038 (0.008)	0.007 (0.005)	0.031 (0.010)	-0.009 (0.005)	0.462 (0.010)

N

Notes: In this table, the dependant variable is the eighth grade score and the regressions do not include pupil fixed effects. The treatments are the eighth grade number of friends by types, and the lagged treatments and scores are from sixth grade. Each row reports estimates from a single regression, including all the treatments reported, cohort dummies and Fixed Effects when reported. Standard errors are clustered by class and reported in parentheses.

**Table 8: Estimated effect of Reciprocal Friends and Followers in Class on Test scores from a Value Added Regression of Eighth Grade Students**

	Treatments Included Separately		Treatments Included Jointly	
	Reciprocal Friends	Followers	Reciprocal Friends	Followers
	(1)	(2)	(3)	(4)
OLS	0.041 (0.016)	0.038 (0.019)	0.037 (0.016)	0.027 (0.019)
OLS with pupil characteristics	0.016 (0.015)	0.030 (0.018)	0.013 (0.015)	0.026 (0.018)
School Fixed Effect	0.024 (0.009)	0.038 (0.012)	0.021 (0.009)	0.032 (0.012)
Class Fixed Effect	0.028 (0.009)	0.041 (0.012)	0.025 (0.009)	0.035 (0.012)
N	7753			

Notes: In this table the dependent variable is the difference between the eighth and the sixth grade score. Each pupil is included once, and therefore there is no pupil fixed effect. The treatments are the eighth grade number of friends by type and the lagged - sixth grade numbers of friends by type. The estimates in columns 1-2 are each from a separate regression. The estimates in each row in columns 3-4 are from the same regression. Standard errors are clustered by class and reported in parentheses.

**Table 9: Estimated Effect of Number of Reciprocal Friends and Followers in Class on Test Scores, By Sub-Groups**

	Reciprocal Friends (1)	Followers (2)	Reciprocal Friends (3)	Followers (4)
<b>A. By Gender</b>	<b>Boys</b>		<b>Girls</b>	
Class and Pupil Fixed Effects	0.021 (0.010)	0.037 (0.009)	0.030 (0.011)	0.036 (0.008)
N	7940		7566	
<b>B. By Parental Education</b>	<b>High Parental Education</b>		<b>Low Parental Education</b>	
Class and Pupil Fixed Effects	0.010 (0.011)	0.024 (0.008)	0.017 (0.010)	0.045 (0.009)
N	6440		9062	
<b>C. By Student's Age</b>	<b>Young</b>		<b>Old</b>	
Class and Pupil Fixed Effects	0.019 (0.012)	0.041 (0.011)	0.010 (0.009)	0.022 (0.008)
N	5908		9656	

Notes: The regressions include class and pupil fixed effects. High parental education is defined as more than 12 years of schooling. The "Young" group includes pupils born in July-December in the cohort year or later. The "Old" group includes pupils born in January-June in the cohort year or earlier. The estimates in columns 1-2 are each from a separate regression. The estimates in columns 3-4 are from the same regression. Standard errors are clustered by class and reported in parentheses.

**Table 10: Estimated Effect of The Quality of Reciprocal Friends and the Number of Reciprocal Friends and Followers on Test Scores**

	Quality of true friends: treatments included seperately		Quality of true friends: treatments included jointly		
	Reciprocal Friends' Mean Father's Education (1)	Reciprocal Friends' Mean Mother's Education (2)	Reciprocal Friends Mean Father's Education (3)	Reciprocal Friends (4)	Followers (5)
<b>A. Class Level Treatments</b>					
OLS	0.055 (0.007)	0.062 (0.007)	0.051 (0.007)	0.073 (0.009)	0.053 (0.006)
OLS with Pupil	0.017 (0.006)	0.019 (0.007)	0.015 (0.006)	0.062 (0.009)	0.050 (0.006)
School Fixed Effect	0.033 (0.004)	0.038 (0.004)	0.031 (0.004)	0.073 (0.005)	0.056 (0.004)
Class Fixed Effect	0.034 (0.004)	0.039 (0.004)	0.031 (0.004)	0.072 (0.005)	0.058 (0.004)
Class and Pupil Fixed	0.011 (0.006)	0.005 (0.007)	0.010 (0.006)	0.017 (0.007)	0.035 (0.006)
<b>B. School Level</b>					
Class and Pupil Fixed	0.012 (0.011)	0.008 (0.011)	0.012 (0.011)	0.007 (0.011)	0.032 (0.008)
N	15506	15506	15506		

Notes: See Table 3. Panel B includes only regressions with pupil and class fixed effects. The estimates in columns 1-2 are each from a separate regression. Each row in columns 3-5 presents estimates from the same regression. The quality of true friends is measured as the average father's or mother's education of all the reciprocal friends who are in the same class as the pupil.



**Table 11: Estimated Effect of Reciprocal Friends and Followers in Class on Behavioral Outcomes**

	Treatments included separately		Treatments included jointly	
	Reciprocal Friends (1)	Followers (2)	Reciprocal Friends (3)	Followers (4)
<b>A. Specification with Pupil and Class Fixed Effectw</b>				
Involment in school fights	-0.012 (0.026)	0.001 (0.019)	-0.012 (0.027)	0.003 (0.019)
Fear from school violence	-0.043 (0.026)	-0.052 (0.019)	-0.031 (0.027)	-0.048 (0.020)
Overall social satisfaction in class	0.051 (0.027)	0.069 (0.020)	0.035 (0.028)	0.064 (0.020)
Overall satisfaction from school	0.063 (0.025)	0.041 (0.018)	0.055 (0.025)	0.034 (0.019)
Time doing homework	0.071 (0.093)	-0.034 (0.068)	0.083 (0.095)	-0.045 (0.069)
<b>B. Simple OLS</b>				
Involment in school fights	-0.065 (0.012)	-0.034 (0.011)	-0.061 (0.013)	-0.020 (0.012)
Fear from school violence	-0.082 (0.009)	-0.052 (0.011)	-0.075 (0.010)	-0.035 (0.009)
Overall social satisfaction in class	0.105 (0.011)	0.095 (0.010)	0.090 (0.011)	0.076 (0.012)
Overall satisfaction from school	0.066 (0.011)	0.050 (0.010)	0.059 (0.011)	0.037 (0.010)
Time doing homework	-0.160 (0.044)	-0.010 (0.041)	-0.165 (0.045)	0.026 (0.039)

Notes: The regressions in panel A include class and pupil fixed effects. The OLS regressions in panel B include only cohort dummies as controls. Standard errors are clustered by class and are reported in parentheses. The estimates in columns 1-2 are each from a separate regression. Each row in columns 3-4 present estimates from the same regression. Standard errors are clustered by class. Standard errors are clustered by class and are reported in parentheses.

**Table 12: Estimated Effect of Reciprocal Friends and Followers in Class on Behavioral Outcomes , by Gender**

	Treatments Included Separately		Treatments Included Together	
	Reciprocal Friends (1)	Followers (2)	Reciprocal Friends (3)	Followers (4)
<b>A. Boys</b>				
Involment in school fights	0.003 (0.049)	-0.074 (0.036)	0.019 (0.050)	-0.076 (0.036)
Fear from school violence	-0.053 (0.044)	-0.052 (0.032)	-0.044 (0.045)	-0.047 (0.033)
Overall social satisfaction in class	0.054 (0.042)	0.074 (0.031)	0.040 (0.042)	0.070 (0.031)
Overall satisfaction from school	0.101 (0.042)	0.105 (0.030)	0.081 (0.042)	0.096 (0.031)
Time doing homework	-0.100 (0.159)	-0.064 (0.115)	-0.088 (0.161)	-0.054 (0.117)
N	1892			
<b>B. Girls</b>				
Involment in school fights	-0.008 (0.030)	0.035 (0.021)	-0.020 (0.031)	0.038 (0.022)
Fear from school violence	-0.033 (0.040)	-0.024 (0.028)	-0.027 (0.040)	-0.020 (0.029)
Overall social satisfaction in class	0.057 (0.042)	0.075 (0.031)	0.035 (0.045)	0.070 (0.032)
Overall satisfaction from school	0.044 (0.038)	-0.030 (0.028)	0.056 (0.039)	-0.039 (0.028)
Time doing homework	0.160 (0.144)	-0.070 (0.102)	0.196 (0.149)	-0.104 (0.105)
N	1902			

Notes: See table 11. All the regressions include class and pupil fixed effects.

## On Line Appendix

**Table A1: Descriptive Statistics in Sub-Groups of the Panel Sample**

	In Class			In School		
	Mean (1)	Min (2)	Max (3)	Mean (4)	Min (5)	Max (6)
<b>1. Boys</b>						
C. Reciprocal friends	2.24 (2.06)	0	8	3.04 2.31	0	8
D. Followers	1.54 (2.04)	0	13	2.48 2.69	0	17
E. Non-reciprocal friends	1.51 (1.90)	0	8	2.44 2.23	0	8
<b>N</b>	8874					
<b>2. Girls</b>						
C. Reciprocal friends	2.36 (2.08)	0	8	3.18 (2.32)	0	8
D. Followers	1.62 2.02	0	13	2.61 (2.79)	0	20
E. Non-reciprocal friends	1.53 (1.89)	0	8	2.47 (2.20)	0	8
<b>N</b>	8274					
<b>3. Young</b>						
C. Reciprocal friends	2.27 (2.05)	0	8	3.04 (2.26)	0	8
D. Followers	1.50 (1.91)	0	13	2.41 (2.57)	0	20
E. Non-reciprocal friends	1.58 (1.94)	0	8	2.55 (2.25)	0	8
<b>N</b>	6468					
<b>4. Old</b>						
C. Reciprocal friends	2.31 (2.09)	0	8	3.15 (2.35)	0	8
D. Followers	1.63 (2.10)	0	13	2.63 (2.83)	0	19
E. Non-reciprocal friends	1.48 (1.86)	0	8	2.39 (2.19)	0	8
<b>N</b>	10746					

**Table A1: continued**

	<b>In Class</b>			<b>In School</b>		
	Mean (1)	Min (2)	Max (3)	Mean (4)	Min (5)	Max (6)
<b>5. High Parental Education</b>						
C. Reciprocal friends	2.50 (2.10)	0	8	3.36 (2.35)	0	8
D. Followers	1.74 (2.18)	0	13	2.85 (2.99)	0	19
E. Non-reciprocal friends	1.44 (1.85)	0	8	2.40 (2.19)	0	8
<b>N</b>	7044					
<b>6. Low Parental Education</b>						
C. Reciprocal friends	2.16 (2.04)	0	8	2.93 (2.27)	0	8
D. Followers	1.47 (1.91)	0	12	2.33 (2.53)	0	20
E. Non-reciprocal friends	1.57 (1.92)	0	8	2.49 (2.23)	0	8
<b>N</b>	10098					

Notes: The figures in the table denote the number of friends in each category in the panel sample. High parental education is defined as more than 12 years of schooling. The "Young" group is includes pupils born in July-December in the cohort year or later. The "Old" group includes pupils born in January-June in the cohort year or earlier.

**Table A2: Estimated Effect of Number of Reciprocal Friends, Followers, and Narrow Social Network in Class on Test Scores in Math, English, and Hebrew**

	Treatments included separately				Treatments included jointly		
	Reciprocal Friends (1)	Followers (2)	Narrow Social Network (3)	Narrow Social Network minus Reciprocal Friends (4)	Reciprocal Friends (5)	Followers (6)	Narrow Social Network minus Reciprocal Friends (7)
<b>A. Class Level Treatments</b>							
OLS	0.088 (0.007)	0.077 (0.006)	0.034 (0.004)	0.026 (0.005)	0.087 (0.008)	0.064 (0.006)	-0.027 (0.006)
OLS with Pupil Characteristics	0.072 (0.007)	0.067 (0.006)	0.024 (0.004)	0.012 (0.005)	0.077 (0.007)	0.062 (0.006)	-0.035 (0.006)
School Fixed Effect	0.083 (0.004)	0.075 (0.004)	0.035 (0.002)	0.028 (0.004)	0.077 (0.005)	0.061 (0.004)	-0.019 (0.004)
Class Fixed Effect	0.086 (0.004)	0.078 (0.004)	0.038 (0.002)	0.031 (0.004)	0.077 (0.005)	0.063 (0.004)	-0.017 (0.004)
Class and Pupil Fixed Effects	0.027 (0.007)	0.038 (0.006)	0.012 (0.003)	0.012 (0.005)	0.020 (0.008)	0.036 (0.006)	-0.004 (0.005)
N	15506						

Notes: See Table 3.

**Table A3: Estimated Effect of Self Defined Friends and Followers on Test Scores**

	Treatments included seperately			Treatments included jointly		Treatments included jointly		
	Self Nominated Friends	Followers	Reciprocal Friends Mean Father's Education	Self Nominated Friends	Followers	Self Nominated Friends	Followers	Reciprocal Friends Mean Father's Education
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<b>A. Class Level Treatments</b>								
OLS	0.020 (0.007)	0.077 (0.006)	0.020 (0.003)	0.017 (0.006)	0.076 (0.006)	-0.013 (0.007)	0.074 (0.006)	0.022 (0.003)
OLS with pupil characteristics	0.007 (0.006)	0.067 (0.006)	0.008 (0.003)	0.005 (0.006)	0.067 (0.006)	-0.005 (0.007)	0.067 (0.006)	0.008 (0.003)
School Fixed Effect	0.017 (0.004)	0.079 (0.004)	0.013 (0.002)	0.018 (0.004)	0.080 (0.004)	0.001 (0.005)	0.078 (0.004)	0.013 (0.002)
Class Fixed Effect	0.017 (0.004)	0.082 (0.004)	0.013 (0.002)	0.021 (0.004)	0.084 (0.004)	0.006 (0.005)	0.082 (0.004)	0.011 (0.002)
Class and Pupil Fixed Effects	-0.005 (0.005)	0.038 (0.006)	0.000 (0.002)	-0.002 (0.005)	0.038 (0.006)	-0.003 (0.005)	0.038 (0.006)	0.002 (0.002)
<b>B. School Level Treatments</b>								
Class and Pupil Fixed Effects	-0.014 (0.006)	0.033 (0.008)	-0.003 (0.003)	-0.015 (0.006)	0.033 (0.008)	-0.015 (0.007)	0.033 (0.008)	0.000 (0.003)

Notes: Self defined friends (group A) includes the students listed by student *i* as friends they asked to be with in middle school. The quality of self defined friends is measured as the average father's education for all the self defined friends. The OLS specification includes year dummies as controls. The vector of pupils characteristics includes gender, parental education, number of siblings and dummies for ethnicities. Panel B includes only regressions with pupil and class fixed effects. Standard errors are reported in parentheses. The estimates in columns 1-2 are each from a separate regression. Each row in columns 3-6 presents estimates from the same regression.

**Table A4: Estimated Effect of Number of Reciprocal Friends and Followers in Class on Test Scores, by Subject, From a Regression with Class and Student Fixed Effects**

	Reciprocal Friends	Followers
	(1)	(2)
Math	0.017 (0.011)	0.039 (0.009)
Hebrew	0.024 (0.012)	0.033 (0.010)
English	0.013 (0.012)	0.032 (0.010)

Notes: Each row includes estimated from a single regression. All regressions have pupil and class fixed effects. Standard errors are clustered by class and reported in parentheses.



**Table A5: Non-Linear effect of Reciprocal Friends and Followers on Test Scores**

	In Class		In School	
	Reciprocal Friends	Followers	Reciprocal Friends	Followers
	(1)	(2)	(3)	(4)
One friend	0.040 (0.028)	0.045 (0.023)	0.048 (0.044)	0.002 (0.031)
Two friends	0.014 (0.031)	0.088 (0.029)	-0.006 (0.051)	-0.022 (0.038)
Three friends	0.082 (0.035)	0.101 (0.036)	-0.022 (0.055)	0.061 (0.045)
Four friends	0.042 (0.040)	0.180 (0.041)	-0.053 (0.061)	0.112 (0.050)
Five friends	0.089 (0.045)	0.209 (0.049)	-0.013 (0.068)	0.076 (0.059)
Six or more friends	0.115 0.048	0.291 (0.047)	0.031 (0.073)	0.200 (0.063)

Notes: The estimates in columns 1-2 come from a single regression, and the estimates for columns 3-4 come from a single regression. The treatments are dummy variables for each group. The regressions include pupil and class fixed effect.

**Table A6: Estimated Effect of The Quality of Reciprocal Friends and the Number of Reciprocal Friends, Followers, and Non-Reciprocal Friends on Test Scores**

	Quality of true friends: treatments included seperately		Quality of true friends: treatments included jointly			
	Reciprocal Friends' Mean Father's Education (1)	Reciprocal Friends' Mean Mother Education (2)	Reciprocal Friends Mean Father's Education (3)	Reciprocal Friends (4)	Followers (5)	Non- Reciprocal Friends (6)
<b>A. Class Level</b>						
OLS	0.055 (0.007)	0.062 (0.007)	0.053 (0.006)	0.055 (0.009)	0.044 (0.006)	-0.051 (0.008)
OLS with Pupil Characteristics	0.017 (0.006)	0.019 (0.007)	0.016 (0.006)	0.044 (0.009)	0.041 (0.006)	-0.054 (0.008)
School Fixed Effect	0.033 (0.004)	0.038 (0.004)	0.031 (0.004)	0.056 (0.006)	0.045 (0.004)	-0.046 (0.005)
Classl Fixed Effect	0.034 (0.004)	0.039 (0.004)	0.032 (0.004)	0.055 (0.006)	0.047 (0.005)	-0.043 (0.005)
Class and Pupil Fixed Effects	0.011 (0.006)	0.005 (0.007)	0.010 (0.006)	0.013 (0.007)	0.031 (0.006)	-0.016 (0.006)
<b>B. School Level</b>						
Class and Pupil Fixed Effects	0.012 (0.011)	0.008 (0.011)	0.012 (0.011)	0.001 (0.011)	0.029 (0.008)	-0.026 (0.008)
N	15506	15506	15506			

Notes: See Table 10.

**Table A7: Summary Statistics of Pupils Behavioral Outcomes, Full Sample and By Gender**

	Full Sample	Boys	Girls
	(1)	(2)	(3)
Involment in school fights	1.80 (1.30)	2.27 (1.48)	1.33 (0.88)
Fear of school violence	1.52 (1.14)	1.63 (1.27)	1.41 (0.97)
Overall social feeling	5.14 (1.17)	5.08 (1.20)	5.21 (1.14)
Overall feeling in school	4.85 (1.31)	4.63 (1.40)	5.08 (1.17)
Time doing homework	8.95 (4.72)	8.69 (4.93)	9.22 (4.48)

Notes: Standard deviations are reported in parentheses.